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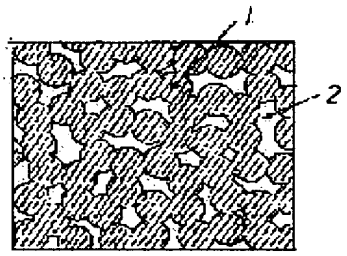
(71)Applicant : ASAHI CHEM IND CO LTD
(72)Inventor : FUJIE AKIRA
TAKAISHI SHOICHI

## (54) SOUND ABSORBER AND ITS INSTALLATION METHOD

(57)Abstract:
PURPOSE: To provide a sound absorber which has an excellent sound absorbing effect, is applicable with small space volume particularly for preventing noises of low frequencies and is excellent in cost effectiveness by forming the sound absorber consisting of a porous molding of resin foamed particles having a peak frequency of a specific range.
CONSTITUTION: This sound absorber is the porous molding of the resin foamed particles 1 having the peak frequency of sound absorptivity of ≥30% in a region of 100 to 3000Hz. The sound absorption characteristic of low-frequency tones degrades and such sound absorber is unsuitable if the peak frequency exceeds 3000Hz. The sound absorber having the peak frequency below 100Hz is hardly obtainable. The porous molding of the resin foamed particles 1 is integrally molded with many pieces of the resin foamed particles 1 by surface-to-surface joining in part of the adjacent particle surfaces and gap parts 2 are formed among these particles. These gap parts 2 do not have a fixed shape in the thickness direction of the molding and exhibit an attenuation effect by multiple reflections and interference at the time the incident sound waves pass the sound ways. Then, the sound absorbing performance of the low-frequency region is enhanced, by which the space size necessary for soundproof installation including rear air layers is reduced.

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CLAIMS

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[Claim(s)]
[Claim 1] The absorption-of-sound object which consists of a porosity Plastic solid of the resin foaming particle which has the peak frequency of 30% or more of acoustic absorptivities in a 100-3000Hz frequency domain.
[Claim 2] The absorption-of-sound object according to claim 1 which the porosity Plastic solid of a resin foaming particle carries out field junction in a part of particle front face where many of the resin foaming particle whose mean particle diameter is 1.5-5.5mm adjoins, and is characterized by having 15 - 40% of volume voidage, and unifying to the whole volume.
[Claim 3] The construction approach of the absorption-of-sound object characterized by to install this absorption-of-sound object on the conditions with which it faces constructing the absorption-of-sound object which consists of a porosity Plastic solid of the resin foaming particle which has the peak frequency of 30% or more of acoustic absorptivities in a 100-3000Hz frequency domain, and sum [ of the meat thickness of this absorption-of-sound object and the thickness of a back air space ] d (m) and frequency [ of a noise source ] f (Hz) fills following the (1) type and (2) types.
$1.03-(1/d)\ 1.7<=f<=17.16-(1/d)\ 1.7$ (1)
$100<=f<=285-(1/d)\ 0.48$ (2)

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the absorption-of-sound object which used the resin foaming particle, and its construction approach. It is related with the absorption-of-sound object using a Plastic solid and its construction approach of a detailed resin foaming particle effective in the noise abatement of engineering works, construction, air-conditioning equipment, and an industrial device.
[0002]
[Description of the Prior Art] As a sound absorbing material, the energy of a sound vibrates air inside a pore-like ingredient, and various ingredients, such as a porous body using carrying out heat loss by friction with a pore internal surface, a plate using changing into vibration of a plate and the film, a filmy body, and a perforated-panel object using a resonance phenomenon, are used. There is much the use at the point that the absorption-of-sound effectiveness is easy to be acquired especially, as for a porosity Plastic solid, i.e., the elasticity polyurethane foaming object which specifically has the fiber aggregates and open cell structures, such as glass wool and rock wool, or the porosity Plastic solid which hardened and calcinated the ceramic grinding particle.
[0003] However, among these, since a ceramic porosity Plastic solid is disadvantageous the point on lightweight nature or a price, it is limited to the special application asked for an elevated temperature or the endurance on an environmental condition. Moreover, an elasticity polyurethane foaming object cannot acquire easily the absorption-of-sound effectiveness stabilized since the destructive condition of the cellular film changed with the manufacture conditions. Therefore, most generally the glass wool and rock wool which are excellent in cheap nature or lightweight nature are used widely.
[0004] By the way, although it has the absorption-of-sound effectiveness which was excellent to loud sound, i.e., the sound of a high-frequency field, to bass, i.e., the sound of low frequency, such a porosity Plastic solid had the thin absorption-of-sound effectiveness, the large thickness of a sound absorbing material had to be taken, or could not but prepare the back air space greatly between the walls (it is hereafter called the rigid wall) and sound absorbing materials which reflect an acoustic wave, and could not but correspond to it. Usually, if a porosity Plastic solid is put on the place of the quarter-wave length of the noise from a rigid wall, the largest acoustic absorptivity will be obtained. For example, to the noise of 200Hz and 100Hz, the space thickness of 430 or 860mm is needed, respectively. Therefore, it was what needs the great space volume and fades in practicality as a cure against noise abatement of bass.
[0005] On the other hand, in the fiber aggregates, such as glass wool, when there is a temperature gradient within and without a wall, the absorption-of-sound engine performance deteriorates by water absorption by the dew condensation phenomenon, and water absorption by invasion of storm sewage. Since it was still more flexible at these fiber aggregate itself, it was what has problems, such as it being necessary to perform attachment construction using subsidiary materials, such as a punching metal and a fixture, to construct in a desired configuration, and doing a bad influence harmful to the body according to inhalation in stimulating the skin moreover at the time of an activity ****.
[0006]
[Problem(s) to be Solved by the Invention] From the field of the absorption-of-sound engine performance, the space volume required for construction, and the workability of construction to the purpose of this invention measuring the efficient cure against noise abatement to the generation source of the noise A space dimension required for the absorption-of-sound construction including a back air space by specifically raising the absorption-of-sound engine performance of a low frequency field is reduced, It is in offering the construction approach of the absorption-of-sound object which makes it possible to simplify the activity at

the time of construction and to raise workability, to eliminate the absorption-of-sound performance degradation problem under the effect of an environmental condition (especially water absorption phenomenon), etc.

[0007]

[Means for Solving the Problem] By using the Plastic solid which many of a resin foaming particle left the opening and unified between particles, this invention improves the above-mentioned fault which the conventional absorption-of-sound object has. Namely, the 1st of this invention is an absorption-of-sound object which consists of a porosity Plastic solid of the resin foaming particle which has the peak frequency of 30% or more of acoustic absorptivities in a 100-3000Hz frequency domain. It faces constructing the becoming absorption-of-sound object. the porosity Plastic solid of a resin foaming particle with which the 2nd [ the ] has the peak frequency of 30% or more of acoustic absorptivities in a 100-3000Hz frequency domain -- since -- Sum [ of the meat thickness of this absorption-of-sound object and the thickness of a back air space ] d (m) and frequency [ of a noise source ] f (Hz) is the construction approach of the absorption-of-sound object characterized by installing this absorption-of-sound object on the conditions with which following the (1) type and (2) types are filled.

[0008]

$1.03-(1/d)\ 1.7<=f<=17.16-(1/d)\ 1.7$ (1)

$100<=f<=285-(1/d)\ 0.48$ (2)

First, the 1st of this invention is explained. As for the absorption-of-sound object used by this invention, it is important that it is the porosity Plastic solid of a resin foaming particle with which an acoustic absorptivity has 30% or more of peak frequency to 100-3000Hz field. The absorption-of-sound nature of bass falls and that to which a peak frequency exceeds 3000Hz is not suitable for the purpose of this invention. Moreover, it is difficult for a peak frequency to obtain a less than 100Hz thing. It is in the condition in which the absorption-of-sound object stuck the acoustic absorptivity to the rigid-body wall here, and is JIS. When the normal incidence sound absorption coefficient specified to A1405 is said and it has a back air space that is, it is not the value which set up the air space between the rigid-body walls and absorption-of-sound objects which reflect an acoustic wave, and was measured. With the absorption-of-sound object of this invention, by preparing a back air space, the peak frequency of an acoustic absorptivity shifts to a low frequency side, and a peak acoustic absorptivity tends to increase. Moreover, the absorption-of-sound object of this invention is characterized by using the porosity Plastic solid of a resin foaming particle as an absorption-of-sound object to there having been nothing that used the porosity Plastic solid of a resin foaming particle as an absorption-of-sound object until now.

[0009] It is as follows when the effectiveness by using the porosity Plastic solid of the above-mentioned resin foaming particle is explained using drawing. First, drawing 1 is the expansion format chart showing one of the examples of cross-section structure of the porosity Plastic solid used by this invention. 1 shows the part of a foaming particle and 2 shows an opening part. In order that the porosity Plastic solid of a resin foaming particle used by this invention may fill the above-mentioned requirements **, field junction is carried out, it is really fabricated in a part of particle front face where many of the resin foaming particle 1 adjoins, and the opening part 2 is formed between the particle. If this opening part 2 has a fixed configuration in the Plastic solid thickness direction, it is not fractured, but that area will be large in the next cross section, and it will be narrow, or where that configuration is changed, it will stand in a row, or it will crook and stand in a row, and this opening part 2 will form the so-called path of the sound stream form structure which became intricate rapid concave convex or in the shape of zigzag considering the width of road in the many directions inside a Plastic solid. For this reason, in case the acoustic wave which carried out incidence passes the above-mentioned sound path, it will also discover the damping effect by the multiple echo or interference.

[0010] If the porosity Plastic solid of a resin foaming particle used for this invention also has the fundamental property of a porous body and an acoustic wave trespasses upon the pore-like absorption-of-sound inside of the body, the air in an opening will vibrate, friction is produced between air and the internal surface of an opening in that case, it becomes heat loss, and the energy of a sound is consumed. In addition, by this invention, since it consists of resin foaming particles which the wall ingredient which forms an opening becomes from much closed cell structures and the wall front face forms the very thin film, it will have the effectiveness which has the function changed into vibration of the film in response to sound pressure energy, namely, was excellent in the absorption-of-sound nature of low frequency. And since it is the Plastic solid which consists of very many resin foaming particles, the absorption-of-sound nature of a bass region improves in multiplication.

[0011] Moreover, in the Plastic solid of a resin foaming particle used with the absorption-of-sound object of this invention, it is desirable to carry out field junction in a part of particle front face where many of the resin foaming particle whose mean particle diameter is 1.5-5.5mm adjoins, to have 15 - 40% of volume voidage, and to unify to the whole volume. These requirements are explained below. The first factor which specifies the configuration of the opening in a foaming particle is the magnitude of the particle which forms the opening, and, as for the mean particle diameter of the Plastic solid of a resin foaming particle, it is desirable that it is the range of 1.5-5.5mm. Thereby, the path of a sound stream form, i.e., the width of face of a sound path, is determined. If particle diameter exceeds 5.5mm, while the number of the pore opening per [ which carries out sound reception as an absorption-of-sound object ] unit area will fall, the wall gross area of the opening in a complete product falls, the function to change sound pressure energy into friction loss falls, and the absorption-of-sound engine performance is spoiled. While the voidage of an absorption-of-sound object falls from relation with the manufacture approach later mentioned as particle diameter is less than 1.5mm and the absorption-of-sound engine performance falls, it becomes difficult to manufacture [ of a difficult Plastic solid with thick meat thickness ] to carry out heat adhesion of the particle of the core part of an absorption-of-sound object. The mean particle diameter of the resin foaming particle of such a point to this invention has 1.5-5.5 desirablemm. Furthermore, it is 2-4mm preferably.

[0012] In addition, the particle size distribution of the resin foaming particle which constitutes an absorption-of-sound object also influences voidage, and influences the absorption-of-sound engine performance. Since a particle small in the gap of a big particle will be incorporated if a particle with big particle diameter and a small particle are intermingled, the path of the above-mentioned sound stream form may be taken up, or volume voidage may fall. Especially, when the ratio of the path of a large drop child and a granule child is a small value, when that abundance has a specific relation in addition (a large drop child / granule child = 6/4), this phenomenon is remarkable, and decline in an acoustic absorptivity takes place.

[0013] It is desirable that the value of the ratio of the maximum particle diameter and the minimum particle diameter takes to 0.3-0.9 within the particle group with which use is presented in this invention. The rate of an opening that become minute restoration when all particle diameter was the same and it fills up in a mold, and adjoining particles carry out field junction and they are formed becomes low, and is not desirable for the absorption-of-sound engine performance. Moreover, it is desirable to become the structure which the waveguide which the width of road fluctuated periodically in the absorption-of-sound object used by this invention to make reflection and interference of an acoustic wave discover effectively became intricate in three dimensions, and opened for free passage, and it is desirable to make into 15 - 40% of volume voidage the opening where junction between particles constitutes junction of the shape of a field instead of punctiform, and is formed between particles to a complete product.

[0014] The second factor which specifies the configuration of an opening is carrying out field junction with the particle which a resin foaming particle's adjoins mutually. Although it is important in order for this to raise the bond strength between the adjoining particles and to make the mechanical strength as a Plastic solid discover, it is thought also from the field of the absorption-of-sound engine performance that it is desirable. The acoustic wave which trespassed upon the opening advances in various the directions, and although reflective dispersion is repeated and decreased, when between the particles which form an opening has joined to punctiform, the probability for an acoustic wave to be reflected compared with the case where field junction is being carried out becomes low. The frequency of a multiple echo increases because between particles joins in the shape of a field. A damping effect is also discovered, when this receives the acoustic wave which carries out incidence from various directions, and the probability which the epidermis film of the resin foaming particle which forms the wall front face changes into vibrational energy also increases and the frequency of a multiple echo increases. That is, although it is the opening which is mutually open for free passage, it is for making many paths used as a dead end form for the advancing acoustic wave.

[0015] In this invention, it is also the description that the degree of the field junction between such particles can adjust easily. That is, in case an absorption-of-sound object is fabricated, it is in using the resin foaming particle which has expansion ability, while the particle in a mold pushes one another mutually by carrying out heating expansion so that a foaming particle may become the volume 1.08 to 1.41 times the volume of original in case these are filled up with, heated and joined to metal mold, it results to field junction, and the absorption-of-sound object have the above-mentioned opening configuration is acquired.

[0016] Moreover, there is voidage to have big effect on the absorption-of-sound engine performance. Although the voidage of a porosity absorption-of-sound object also affects the absorption-of-sound engine performance, since it is the absorption-of-sound object which many of a resin foaming particle comes to join

in this invention, it is desirable to make it 15 - 40% of volume voidage. If voidage exceeds 40%, the mechanical strength which carries out an absorption-of-sound Plastic solid will fall, and the use as a Plastic solid will become difficult substantially. An acoustic absorptivity becomes that voidage is less than 15% with less than 30%, and the absorption-of-sound engine performance deteriorates. ** taken from absorption-of-sound nature and the point of mechanical strength to 20 - 35% is more desirable.

[0017] Next, the manufacture approach of the porosity Plastic solid used by this invention mentioned above is explained. It is advantageous in order to acquire the porosity Plastic solid which has making easy adhesion between the particles from which installing the resin for adhesion which can carry out heat adhesion at temperature lower than the softening foaming temperature of this particle adjoins the front face of a resin foaming particle in this invention, and raising the voidage of a porosity Plastic solid, and specific opening structure. In order that the particles which it has the property to foam and expand with heating, each particle itself expands when metal mold is filled up and it is heated, and adjoin mutually may press it mutually, since a resin foaming particle can obtain bond strength firm enough through the surface resin for heat adhesion, it is very suitable for the purpose of this invention. Furthermore, it is desirable also from the point of acquiring the porosity Plastic solid with which the amount of the resin to be used could be reduced and lightweight nature and adiathermic were added.

[0018] Installing the above-mentioned heat adhesive property resin on the front face of a resin foaming particle Heat adhesion can be carried out at the temperature which becomes [ a resin foaming particle carries out heat softening and comes to expand to altitude / a front, namely, ] the volume 1.08 to 1.41 times the volume of original. It becomes possible to reduce the thermal expansion of a foaming particle as the result, and to maintain high voidage, the field-like junction between the above foaming particles becomes easy, the opening configuration of a sound stream form is formed, and the porosity Plastic solid excellent in absorption-of-sound nature is acquired. Moreover, if the above-mentioned process is used, energy expenditure can be reduced, shaping in a short time will be attained, and the effectiveness excellent also in productivity will be brought about.

[0019] the resin foaming particle as used in the field of this invention is content ******** about an organic volatility foaming agent or a pyrolysis nature foaming agent at resin, such as general-purpose thermoplastics, for example, polystyrene, high impact polystyrene, ABS plastics, polyethylene (high density, low consistency), polypropylene, poly MECHIRUCHITA acrylate, polyvinylidene chloride copolymerization resin, nylon 6, nylon 6 and 6, and polyethylene terephthalate. Preferably as a particle which has such expansibility, there are the fizz resin particle and foaming particle which use polystyrene, polyethylene, a polypropylene bilene, polymethylmethacrylate, vinylidene-chloride system resin, a polyphenylene ether polystyrene alloy, etc. as material resin, and it is produced industrially.

[0020] Of course, if too much heating is performed, in order that expansion of a resin particle may become large and the opening between particles may disappear, it is important to choose the combination which made suitable relation between the temperature to which these fizz particle expands, and the temperature in which the resin for adhesion installed by the particle front face carries out heat adhesion. Therefore, as a fizz resin particle, since it is not necessary to manage heating conditions strictly in order for what takes a slow expansion rate with thermal heating of steam etc. to attain the target voidage, a fizz vinylidene-chloride system resin particle is an especially suitable material particle.

[0021] It becomes a fizz vinylidene-chloride system resin particle from a vinylidene chloride, and this and one or more sorts of copolymerizable vinyl monomers. The resin particle which is not foamed [ the glass transition point made the vinylidene-chloride copolymer 85 degrees C or more contain / vinylidene chloride / an organic volatility foaming agent including 30 % of the weight or more to foam ], And it is the good thing which expands with both heating and is indicated by the detail at JP,63-170433,A and JP,63-170434,A about both of the foaming particle of the closed cell structure acquired by carrying out heating foaming of it. A fizz particle is easily obtained by adjusting adjusting the amount of the foaming agent to contain or the aging conditions of a pre-expansion particle, i.e., processing temperature, and the time amount of those.

[0022] Moreover, the foaming spall which cut out the Plastic solid without the opening used as a foaming heat insulator can also be offered as a raw material of this invention. Next, the resin for adhesion which is installed by the front face of the resin foaming particle of this invention and in which heat welding is possible is explained. It is desirable to choose the following [ the softening temperature of the synthetic-resin material particle which softening temperature is 70 degrees C or more, and is used as this resin for adhesion ]. The fluidity of the synthetic-resin material particle by which softening temperature was installed by the front face that it is easy to be tinctured with adhesiveness in a less than 70-degree C thing is bad, and

the restoration nature to the handling metallurgy mold in a manufacture process serves as a defect. Moreover, it deforms, when receiving heat depending on the operating environment of the fabricated product, and it produces un-arranging. On the other hand, if the softening temperature of the resin for adhesion exceeds the softening temperature of a synthetic-resin material particle, heat deformation of a material particle will become large with heating at the time of fabrication, and it will become difficult to acquire a porosity Plastic solid with high voidage.

[0023] There are a polyvinyl chloride, an acrylonitrile styrene copolymer (AS), acrylonitrile-butadiene-styrene copolymer (ABS), a styrene maleic-anhydride copolymer, a styrene acrylic-acid copolymer, acrylic resin, etc. as thermoplastics which has the vinyl acetate system adhesives of a vinyl system classified, for example as thermoplastic adhesive, acrylic adhesives, ethylene vinyl acetate copolymerization adhesives and polyamide system adhesives, polyester system adhesives, heat or plastic polyurethane adhesive, and a polar group as the above-mentioned resin for adhesion.

[0024] As what [ for heat adhesion / resin ] is desirable in the case of the fizz polyvinylidene chloride system resin particle which is a suitable particle material for this invention, the vinyl monomer which has as a substituent the resin with which copolymerization of the vinyl monomer which has a polar group was carried out, i.e., a halogen radical, a carboxylic-acid radical, an ester group, a cyano group, a nitro group, etc. is resin by which copolymerization was carried out at least 5% of the weight or more, and it is ASTM. D That whose BIKATTO softening temperature measured by 1525 is 70-115 degrees C can be used. Use is presented with the resin for these heat adhesion in the form of a solvent solution, an emulsion, or hot melt, and it can be properly used according to the purpose. Of course, it is also possible to add the additive for making various functions add into the solution of the resin for adhesion, and it is the process which was excellent also for the improvement in addition functional. For example, things, such as organic, various flame retarders of an inorganic system, a coloring agent of a pigment or a color, conductive matter, an antistatic agent, and a thermostabilizer, can be used.

[0025] Next, one mode of the concrete manufacture approach of the Plastic solid of the resin firing particle of this invention is explained. The solvent solution of 2 - 10 % of the weight of resin for adhesion or 20 - 60% of the weight of an emulsion solution is mixed so that the resin solid content for adhesion may serve as 5 - 15 weight section to the fizz resin particle 100 weight section. the mixer generally used as mixing of grain on the occasion of mixing -- it can be used -- for example, a ribbon blender etc. -- using -- the resin solution for adhesion -- addition -- or a spray is carried out and the front face of a material particle is made to carry out covering installation

[0026] Even if the bond strength as a Plastic solid which the above-mentioned material particle joined [ the resin solid content for adhesion ] through the resin for adhesion under in 5 weight sections is inadequate and it exceeds 15 weight sections, it does not act effectively in reinforcement and becomes disadvantageous economically. Although the solid content concentration of the resin solution for adhesion can be suitably chosen according to the purpose, in the case of a solvent solution, in the case of an aquosity emulsion, 20 - 60% of the weight of a thing can use it preferably two to 10% of the weight.

[0027] If the above-mentioned mixing is completed, it dries if needed, and the pre-expansion process which carries out heating foaming and adjusts expansion ratio will be presented, or a direct forming cycle will be presented. It is desirable to raise the restoration nature to metal mold, after having foamed, carrying out desiccation processing and giving lightweight nature and a fluidity, especially when shaping of a molded product with a complicated configuration is presented. The resin foaming particle which performed such processing is supplied to the general-purpose foaming automatic making machine in a mold, is more than the softening temperature of the resin for adhesion after metal mold restoration, is heated below at the foaming temperature of a resin foaming particle, and acquires a Plastic solid through the process of cooling. In this way, high voidage is maintained and the porosity Plastic solid which is excellent in the absorption-of-sound nature of this invention by which the opening structure between particles was controlled is acquired.

[0028] Next, the 2nd of this invention is explained. In absorption-of-sound construction, it is most important to reduce a space dimension required in order to install a sound absorbing material as much as possible, and to make the absorption-of-sound engine performance discover to the maximum extent. It is desirable to make in agreement the frequency from which for that the acoustic absorptivity of the porosity absorption-of-sound object of this invention serves as the maximum peak, and the frequency of a noise source.

[0029] These concrete contents are explained using drawing 2 using the sound absorption characteristics of the porosity Plastic solid of this invention. Drawing 2 analyzes the effect which the sum d of the meat thickness of a porosity Plastic solid and a back air bed depth has on the peak frequency F of the acoustic absorptivity at that time. the case (d=lambda / 4= -- 344/4f) where straight-line ** is installed in the place of

the quarter-wave length of the noise source which is just going to discover the absorption-of-sound effectiveness that the conventional porous body is the largest for a porosity Plastic solid namely, f=344/4d:, however acoustic velocity -- a part for 344m/-- carrying out -- it is shown and straight-line ** shows the wavelength (1/8) of the noise source to which the conventional porous body is just going to discover the largest absorption-of-sound effectiveness for a porosity Plastic solid used as the space thickness of 1/the 2. The mark is the point that have 60% or more of acoustic absorptivity in the peak frequency of an acoustic absorptivity, and d becomes below wavelength (1/8). The above-mentioned acoustic absorptivity O mark at 30% or more O At less than 60% And it is the point that d becomes below wavelength (1/4) exceeding wavelength (1/8), and an acoustic absorptivity is less than 30%, or x mark is the point that d exceeds wavelength (1/4).

[0030] First, it is required to install this Plastic solid on the conditions with which sum [ of the meat thickness of a porosity Plastic solid and the thickness of a back air space ] d (m) and frequency [ of a noise source ] f (Hz) fills following the (1) type and (2) types in this invention.

1.03-(1/D) 1.7<=f<=17.16-(1/D) 1.7 (1)

100<=f<=285-(1/D) 0.48 (2)

f< 1.03-(1/D) 1.7 **** -- an acoustic absorptivity falls serially and the meat thickness of a porosity Plastic solid becomes small too much, and since shaping is difficult, it is not suitable. On the other hand, it is f> 17.16-(1/d) 1.7. Since an acoustic absorptivity falls gradually and turns into less than 30% of acoustic absorptivity, and d will become thick compared with the conventional porous body if it is going to take out the desired absorption-of-sound engine performance even if it exceeds, the advantage cannot be discovered.

[0031] Since the wavelength of an acoustic wave becomes large compared with Above d in f< 100, an acoustic absorptivity falls rapidly. It becomes difficult to secure 30% or more of acoustic absorptivity. On the other hand, in 285and(1/D) 0.48<f the hole which corresponded when there was no back air space (i.e., when carrying out absorption-of-sound construction only by the thickness of the porosity Plastic solid of this invention), and exceeded the peak frequency of an acoustic absorptivity -- since it becomes the absorption of sound to the acoustic wave by the side of a frequency, the absorption-of-sound engine performance will fall gradually.

[0032] It sets in the relation between f and D, and is with the conventional absorption-of-sound object. (1/d) With the porosity absorption-of-sound object of this invention, the biggest description is to ruling over by the linear expression to state (1/d) and rule over by ****. If it puts in another way, especially even if the thickness of a back air space is thin, it is the big description that the effective absorption-of-sound effectiveness is shown to the noise of low frequency, and the porosity Plastic solid of this invention can reduce greatly the requisite space volume for absorption of sound. Furthermore, it is desirable that it is satisfied with considering as the construction which was excellent rather than it made the conditions (d becomes 1/8 or less wave) which an acoustic absorptivity is 60% or more, and construction space thickness can reduce by half from the conventional porosity absorption-of-sound object add and the absorption-of-sound engine performance and the requisite space volume were reduced of the field of the polygon EFCGH surrounded by O mark in drawing 2 . A straight line EF expresses the relation between the back air bed depth in the meat thickness of the minimum of a porosity Plastic solid required for an acoustic absorptivity to become 60% or more, and the peak frequency of an acoustic absorptivity, and a straight line HG shows D= (wavelength) / 8 here. If a coordinate (D, F) shows a polygon EFCGH, it will become Point E (0.014 2195), Point F (0.087 100), Point C (0. 35,100), Point G (0. 32,135), and Point H (0.026 1630).

[0033] Although the acoustic absorptivity said by this invention is defined here by the measured value by the vertical-incidence method Since a sound-source frequency also has width of face and has an incidence sound from various include angles in the actual noise, Although it is desirable to face and determine a construction specification as the practical use evaluation instead of a thing for which it can opt uniquely, it is required to set to f (Hz) the frequency from which sound pressure level serves as max in the frequency domain of the noise, and to satisfy the above-mentioned relation at least about this f.

[0034] With the conventional technique, control of the difficult voidage or the magnitude of an opening becomes easy by this invention, the absorption-of-sound engine performance is changed by controlling these according to the purpose of use, or various configurations can be processed and a thing suitable as an absorption-of-sound Plastic solid with which various industrial devices can be equipped is obtained. By using a fizz particle, it can develop as a new industrial member which has adiathermic, and the function of lightweight nature and absorption-of-sound nature collectively in the part which forms the air course of air-conditioning equipment, such as an air-conditioner with which especially silence is called for, and a ventilating fan, a duct, etc. Moreover, also in the construction field, the expansion as a unique material is

expectable.
[0035]
[Example] Hereafter, an example explains this invention. In addition, the evaluation approach used by this invention is as follows.
(1) The nominal dimension to which a resin foaming particle with a mean particle diameter of 100g is specified by JISZ8801 performs ****** using 5.6, 4.75.4, 3.35, 2.36, 1.7, and the standard sieve it is [ standard sieve ] 1.4 or 1mm. di an eye -- passing -- di+1 [ and ] The mean particle diameter di of the stopping particle, and weight rate Xi it is -- if -- the mean particle diameter of each classification article -- di = (di and di+1) It is given by one half.
[0036] Mean particle diameter ds of all particles It asks by the degree type.
ds = The inside of each group classified and obtained by measurement of the sigmaXi di(2) particle-size-distribution preceding clause, and the minimum particle diameter dmin It defines by the value which **(ed) with the maximum particle diameter dmax.
(3) Measure based on tensile strength JISA 9511.
(4) The porosity Plastic solid of the bulk volume (V1) of voidage appearance is immersed into the measuring cylinder which filled the water of a constant rate, measure the increment volume at that time (V2), and ask by the degree type.
[0037] {(V1-V2) /V1} x Based on the 100(5) acoustic absorptivity JISA 1405, a normal incidence sound absorption coefficient (standing wave method) is measured.
** Measure the acoustic absorptivity at the time of specifying an absorption-of-sound object ingredient in the condition without a back air space, i.e., the condition of having stuck to the rigid wall, about each frequency.
[0038] ** Say the value which deducted the acoustic-absorptivity value measured by the approach of ** term in each frequency from the acoustic-absorptivity value at the time of preparing the rise value of the acoustic absorptivity at the time of setting up a back air space, and a back air space.
** Calculate the value which deducted the value measured like [ after making the water of 50% of volume of the whole product absorb water in an absorption-of-sound object sample ] ** term from the acoustic absorptivity measured by the acoustic-absorptivity fall value after water absorption processing, and ** term about each frequency.
[0039]
[Example 1] The divinylbenzene of the 0.02 weight section was added for a vinylidene chloride, N-phenyl maleimide, acrylonitrile, and styrene to the 42, 2.4, and 44. 3 or 11.3-mol % mixture 100 weight section of a presentation ratio, respectively, and the copolymer-resin particle was obtained by the suspension-polymerization method. Sinking-in processing was performed having applied HCFC-142b to this at 70 degrees C for 24 hours. The obtained fizz resin particle contained HCFC[ 10% of the weight of ]142b.
[0040] The fizz resin particle by which spray addition was carried out and it mixed for 15 minutes, and aeration of the 35-degree C warm air was carried out after that, it dried, and acrylic hot glue was installed by the front face was obtained having supplied this fizz resin particle 100 weight section to the ribbon blender, and carrying out **** mixing of the acrylic emulsion (Konishi, SP-210) 20 weight section. The pre-expansion particle which foamed to this fizz resin particle with the steam of 0.2kg/cm2-G was obtained. This pre-expansion particle was classified using the standard sieve, and it distributed to particle size distribution as shown in Table 1, and five groups who have mean particle diameter.
[0041] Each group's pre-expansion particle was supplied to 300x300x25mm shaping metal mold with the general-purpose automatic making machine for styrene foam, by steam ** which shows double-sided heating in Table 1 continuously for 10 seconds with 0.1kg/cm2 steam in heating on the other hand, for 10 seconds, water cooling of the line was carried out and it was released from mold. The result of having measured the voidage of the Plastic solid which has the obtained opening, peak acoustic absorptivity and frequency in the condition of having stuck to the rigid wall, and tensile strength is doubled, and it is shown in Table 1.
[0042] As for the porosity Plastic solid by the resin foaming particle of this invention, it turns out that a high acoustic absorptivity is shown in a 100-3000Hz field in the state of rigid wall adhesion, and the value of an acoustic absorptivity is also rising with the increment in voidage so that clearly from the result of Table 1.
[0043]
[Table 1]

| 実施例1 実験No | 使用粒子の性状 | | | 成形条件 スチーム圧力 | 成形体の特性 | | | |
|---|---|---|---|---|---|---|---|---|
| | 粒子径範囲 mm | 平均粒子径 mm | 粒子径分布 mm | | 空隙率 % | ピーク吸音率 % | ピーク周波数 Hz | 引張強度 kg/cm2 |
| 1 | 2.8～4.0 | 3.5 | 0.70 | 0.2 | 35 | 93 | 2200 | 1.8 |
| 2 | 2.0～3.4 | 2.9 | 0.59 | 0.2 | 31 | 85 | 2000 | 2.0 |
| 3 | 4.8～5.6 | 5.2 | 0.86 | 0.3 | 26 | 45 | 1600 | 2.3 |
| 4 | 1.5～4.8 | 1.7 | 0.31 | 0.3 | 15 | 32 | 900 | 3.4 |
| 5 | 0.8～4.0 | 1.2 | 0.20 | 0.4 | 10 | 13 | 600 | 4.5 |

[0044]
[Example 2] When meat thickness acquired 100, 50, 25, and the porosity Plastic solid that is 15 or 10mm, respectively and measured voidage according to the same process condition using the same pre-expansion particle as the above-mentioned experiment No.1, and 2 and 3, they were 30, 33, 25, and 28 or 15%, respectively. In this way, about the acquired porosity Plastic solid, the thickness of a back air space is changed, frequency dependent [ of an acoustic absorptivity ] is measured, and the result of having asked for the peak frequency from which an acoustic absorptivity serves as max is shown in Table 2.
[0045]
[Table 2]

| 実験No | 使用粒子 | 成形体 肉厚 mm | 成形体 空隙率% | 吸音率のピーク周波数 上段：周波数（Hz） 下段：背後空気層（mm） | | |
|---|---|---|---|---|---|---|
| 6 | ③と同じ | 100 | 30 | 860 | 270 | 100 |
| | | | | 0 | 100 | 250 |
| 7 | ①と同じ | 50 | 33 | 1200 | 400 | 190 |
| | | | | 0 | 50 | 100 |
| 8 | ③と同じ | 25 | 25 | 1600 | 650 | 310 |
| | | | | 0 | 15 | 40 |
| 9 | ①と同じ | 15 | 28 | 2000 | 530 | 110 |
| | | | | 0 | 15 | 60 |
| 10 | ④と同じ | 10 | 15 | 2600 | 400 | 100 |
| | | | | 0 | 20 | 55 |

[0046] next, the above-mentioned result -- the sum D of the peak frequency F of an acoustic absorptivity, the meat thickness of a porosity Plastic solid, and a back air bed depth -- both -- a logarithm -- it will become drawing 2 if it plots and illustrates. Straight-line [ in drawing ] ** and ** show D=lambda/4, and D=lambda/8, respectively. lambda expresses the wavelength in each frequency of an acoustic wave here. Moreover, it is the point that the acoustic absorptivity of the point and O mark with which are satisfied that an acoustic absorptivity [ in / in O mark / the peak frequency of an acoustic absorptivity ] is 60% or more, and D is lambda/8 or less is less than 60% at 30% or more, and an acoustic absorptivity is less than 30%, or D exceeds lambda/4, as for the point that D becomes lambda/4 or less exceeding lambda/8, and x mark.
[0047] Furthermore, the acoustic absorptivity in a peak frequency is 60% or more, and the conditions which can reduce construction space thickness by half compared with the conventional porosity absorption-of-sound object are the fields of a polygon EFCGH.
[0048]
[Example 3] The following conditions estimated frequency dependent [ of an acoustic absorptivity ], using the Plastic solid of experiment No.2 of an example 1 as a porosity Plastic solid.
** O and less than 30% of case were made into x for the case where the value which deducted the measured

value of a rigid wall adhesion condition shows 30% or more of rise from the acoustic-absorptivity value at the time of setting a back air space as 25mm.
** The distance of a back air space was changed, the acoustic absorptivity was measured, and the case where O and 100mm were exceeded for the case where the sum D with space thickness (25mm) required in order that the acoustic absorptivity in each frequency may exceed 50%, i.e., the meat thickness of a porosity Plastic solid, and the thickness of a back air space is less than 100mm was made into x.
** The case where the acoustic absorptivity after water absorption processing fell exceeding 10% compared with processing before was made as x, and less than 10% was made into O.
[0049] The above-mentioned result and evaluation of workability were doubled and it was shown in Table 3. In addition, evaluation of workability was judged by the necessity of the difficulty of attachment of the absorption-of-sound object at the time of assuming absorption of sound of the fan for air-conditioning therefore a required fixture, and a subsidiary material. If metal mold is created, that the Plastic solid of a desired configuration can be mass-produced, and in order for what is necessary just to be to include in equipment as it is, it excels in the porosity Plastic solid of this invention at workability.
[0050]
[Table 3]

| 実施例3 周波数Hz | 背後空気層による吸音率の上昇% | 施工に必要な空間厚み mm | 吸水による吸音率低下 % | 施工性 取付の難易性 | 施工性 治具の要否 |
|---|---|---|---|---|---|
| 2000 | — | 0, ○ | 5, ○ | ○ | ○ |
| 1000 | — | 0, ○ | 5, ○ | | |
| 750 | 5, △ | 0, ○ | 3, ○ | | |
| 500 | 60, ○ | 10, ○ | 10, ○ | | |
| 250 | 53, ○ | 50, ○ | 3, ○ | | |
| 125 | 35, ○ | 75, ○ | 0, ○ | | |

[0051]
[The example 1 of a comparison] a consistency -- 24 kg/m3 it is -- the result of having performed the same evaluation as an example 3 using the absorption-of-sound object of the glass wool whose meat thickness is 25mm is shown in Table 4. In this case, in order to prevent scattering of the glass fiber by airstream, it is necessary to carry out package sewing with a cheesecloth, and since the member and fixture for supporting it in order to prepare a back air space are needed, it is inferior to workability.
[0052]
[Table 4]

| 比較例1 周波数Hz | 背後空気層による吸音率の上昇% | 施工に必要な空間厚み mm | 吸水による吸音率低下 % | 施工性 取付の難易性 | 施工性 治具の要否 |
|---|---|---|---|---|---|
| 2000 | — | 0、○ | 60、× | × | × |
| 1000 | — | 0、○ | 50、× | | |
| 750 | 8、△ | 0、○ | 35、× | | |
| 500 | 15、△ | 0、○ | 40、× | | |
| 250 | 10、△ | 100、× | 10、○ | | |
| 125 | 3、△ | 200、× | 5、○ | | |

[0053]
[Effect of the Invention] The absorption-of-sound object using a resin foaming particle and its construction approach of this invention are the absorption-of-sound object and the construction approach of it being excellent in the absorption-of-sound effectiveness, and constructing to little space volume especially to the noise abatement of low frequency of having excelled also economically.

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[Translation done.]

* NOTICES *



1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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DRAWINGS

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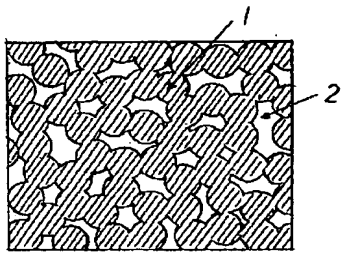
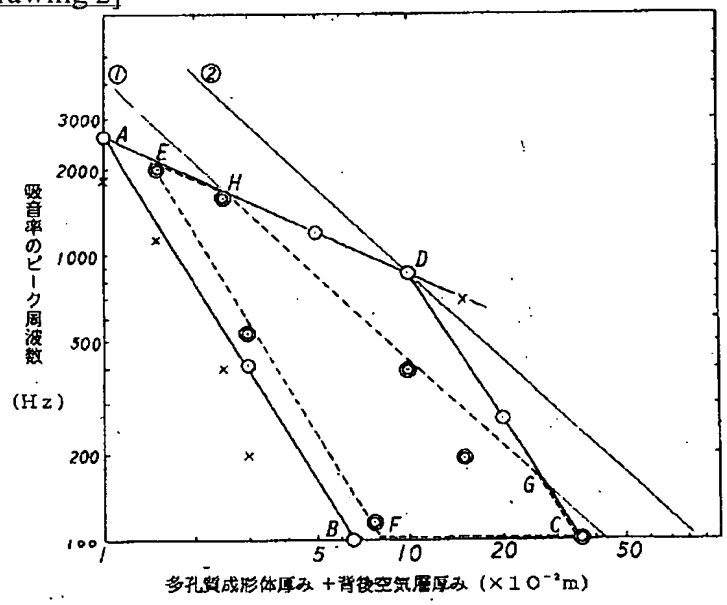
[Drawing 1]




[Drawing 2]

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[Translation done.]

* NOTICES *



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CORRECTION OR AMENDMENT

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[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
[Section partition] The 2nd partition of the 6th section
[Publication date] September 21, Heisei 13 (2001. 9.21)

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B29C  44/00
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F24F  13/02
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B29L  31:00
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[FI]

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G10K  11/16        C
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F24F  13/02        H
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[Procedure revision]
[Filing Date] December 4, Heisei 12 (2000. 12.4)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] 0030
[Method of Amendment] Modification
[Proposed Amendment]
[0030] First, it is required to install this Plastic solid on the conditions with which sum [ of the meat thickness of a porosity Plastic solid and the thickness of a back air space ] d (m) and frequency [ of a noise source ] f (Hz) fills following the (1) type and (2) types in this invention.
1.03-(1/d) 1.7<=f<=17.16-(1/d) 1.7 (1)
100<=f<=285-(1/d) 0.48 (2)
f< 1.03-(1/d) 1.7 **** -- an acoustic absorptivity falls serially and the meat thickness of a porosity Plastic solid becomes small too much, and since shaping is difficult, it is not suitable. On the other hand, it is f> 17.16-(1/d) 1.7. Since an acoustic absorptivity falls gradually and turns into less than 30% of acoustic absorptivity, and d will become thick compared with the conventional porous body if it is going to take out the desired absorption-of-sound engine performance even if it exceeds, the advantage cannot be discovered.
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] 0031
[Method of Amendment] Modification
[Proposed Amendment]

[0031] Since the wavelength of an acoustic wave becomes large compared with Above d in f< 100 the hole which the acoustic absorptivity fell rapidly and it became difficult to secure 30% or more of acoustic absorptivity, corresponded when there was no back air space on the other hand at 285and(1/d) 0.48<f (i.e., when carrying out absorption-of-sound construction only by the thickness of the porosity Plastic solid of this invention), and exceeded the peak frequency of an acoustic absorptivity -- since it becomes the absorption of sound to the acoustic wave by the side of a frequency, the absorption-of-sound engine performance will fall gradually.
[Procedure amendment 3]
[Document to be Amended] Specification
[Item(s) to be Amended] 0032
[Method of Amendment] Modification
[Proposed Amendment]
[0032] It sets in the relation between f and d, and is with the conventional absorption-of-sound object. (1/d) With the porosity absorption-of-sound object of this invention, the biggest description is to ruling over by the linear expression to state (1/d) and rule over by ****. If it puts in another way, especially even if the thickness of a back air space is thin, it is the big description that the effective absorption-of-sound effectiveness is shown to the noise of low frequency, and the porosity Plastic solid of this invention can reduce greatly the requisite space volume for absorption of sound. Furthermore, it is desirable that it is satisfied with considering as the construction which was excellent rather than it made the conditions (d becomes 1/8 or less wave) which an acoustic absorptivity is 60% or more, and construction space thickness can reduce by half from the conventional porosity absorption-of-sound object add and the absorption-of-sound engine performance and the requisite space volume were reduced of the field of the polygon EFCGH surrounded by O mark in drawing 2. A straight line EF expresses the relation between the back air bed depth in the meat thickness of the minimum of a porosity Plastic solid required for an acoustic absorptivity to become 60% or more, and the peak frequency of an acoustic absorptivity, and a straight line HG shows d= (wavelength) / 8 here. If a coordinate (D, F) shows a polygon EFCGH, it will become Point E (0.014 2195), Point F (0.087 100), Point C (0. 35,100), Point G (0. 32,135), and Point H (0.026 1630).
[Procedure amendment 4]
[Document to be Amended] Specification
[Item(s) to be Amended] 0046
[Method of Amendment] Modification
[Proposed Amendment]
[0046] next, the above-mentioned result -- the sum d of the peak frequency F of an acoustic absorptivity, the meat thickness of a porosity Plastic solid, and a back air bed depth -- both -- a logarithm -- it will become drawing 2 if it plots and illustrates. Straight-line [ in drawing ] ** and ** show d=lambda/4, and d=lambda/8, respectively. lambda expresses the wavelength in each frequency of an acoustic wave here. Moreover, it is the point that the acoustic absorptivity of the point and O mark with which are satisfied that an acoustic absorptivity [ in / in O mark / the peak frequency of an acoustic absorptivity ] is 60% or more, and d is lambda/8 or less is less than 60% at 30% or more, and an acoustic absorptivity is less than 30%, or d exceeds lambda/4, as for the point that d becomes lambda/4 or less exceeding lambda/8, and x mark.
[Procedure amendment 5]
[Document to be Amended] Specification
[Item(s) to be Amended] 0048
[Method of Amendment] Modification
[Proposed Amendment]
[0048]
[Example 3] The following conditions estimated frequency dependent [ of an acoustic absorptivity ], using the Plastic solid of experiment No.2 of an example 1 as a porosity Plastic solid. ** O and less than 30% of case were made into x for the case where the value which deducted the measured value of a rigid wall adhesion condition shows 30% or more of rise from the acoustic-absorptivity value at the time of setting a back air space as 25mm. ** The distance of a back air space was changed, the acoustic absorptivity was measured, and the case where O and 100mm were exceeded for the case where the sum d with space thickness (25mm) required in order that the acoustic absorptivity in each frequency may exceed 50%, i.e., the meat thickness of a porosity Plastic solid, and the thickness of a back air space is less than 100mm was made into x. ** The case where the acoustic absorptivity after water absorption processing fell exceeding 10% compared with processing before was made as x, and less than 10% was made into O.

[Translation done.]

# PATENT ABSTRACTS OF JAPAN

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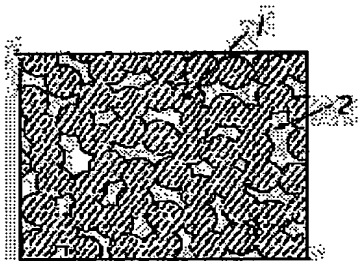
B29L 31:00

(21)Application number : 05-311584
(22)Date of filing : 13.12.1993

(71)Applicant : ASAHI CHEM IND CO LTD
(72)Inventor : FUJIE AKIRA
TAKAISHI SHOICHI

## (54) SOUND ABSORBER AND ITS INSTALLATION METHOD

(57)Abstract:
PURPOSE: To provide a sound absorber which has an excellent sound absorbing effect, is applicable with small space volume particularly for preventing noises of low frequencies and is excellent in cost effectiveness by forming the sound absorber consisting of a porous molding of resin foamed particles having a peak frequency of a specific range.
CONSTITUTION: This sound absorber is the porous molding of the resin foamed particles 1 having the peak frequency of sound absorptivity of ≥30% in a region of 100 to 3000Hz. The sound absorption characteristic of low-frequency tones degrades and such sound absorber is unsuitable if the peak frequency exceeds 3000Hz. The sound absorber having the peak frequency below 100Hz is hardly obtainable. The porous molding of the resin foamed particles 1 is integrally molded with many pieces of the resin foamed particles 1 by surface-to-surface joining in part of the adjacent particle surfaces and gap parts 2 are formed among these particles. These gap parts 2 do not have a fixed shape in the thickness direction of the molding and exhibit an attenuation effect by multiple reflections and interference at the time the incident sound waves pass the sound ways. Then, the sound absorbing performance of the low-frequency region is enhanced, by which the space size necessary for soundproof installation including rear air layers is reduced.

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(43)公開日　平成７年(1995)７月４日

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| Ｂ２９Ｃ　44/00 | | | | |
| Ｅ０４Ｂ　1/82 | | Ｆ | | |
| | | | Ｇ１０Ｋ　11/ 16 | Ｃ |
| | | 9268－4Ｆ | Ｂ２９Ｃ　67/ 22 | |

審査請求　未請求　請求項の数３　ＯＬ　（全　９　頁）　最終頁に続く

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(22)出願日　平成５年(1993)12月13日

(71)出願人　000000033
旭化成工業株式会社
大阪府大阪市北区堂島浜１丁目２番６号

(72)発明者　富士栄　昭
三重県鈴鹿市平田中町１番１号　旭化成工業株式会社内

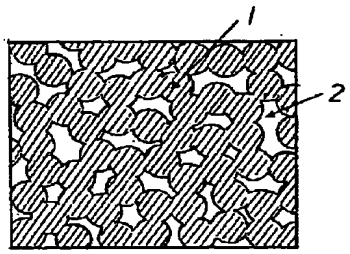
(72)発明者　高石　彰一
三重県鈴鹿市平田中町１番１号　旭化成工業株式会社内

(54)【発明の名称】　吸音体およびその施工方法

(57)【要約】

【目的】　樹脂発泡粒子の多数個が一体化した多孔質成形体を用いた吸音性能に優れ、施工に必要な空間容積を縮小でき、作業性に優れた吸音体及びその施工方法を提供する。

【構成】　１００～３０００Ｈｚの周波数領域に吸音率３０％以上のピーク周波数を有す樹脂発泡粒子の多孔質成形体からなる吸音体およびその施工方法。



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【特許請求の範囲】

【請求項1】　１００～３０００Ｈｚの周波数領域に吸音率３０％以上のピーク周波数を有する樹脂発泡粒子の多孔質成形体からなる吸音体。

【請求項2】　樹脂発泡粒子の多孔質成形体が、平均粒子径が１．５～５．５mmの樹脂発泡粒子の多数個が隣接する粒子表面の一部で面接合し、全体容積に対して１５～４０％の容積空隙率を有して一体化していることを＊特徴とする請求項１記載の吸音体。

【請求項3】　１００～３０００Ｈｚの周波数領域に吸音率３０％以上のピーク周波数を有する樹脂発泡粒子の多孔質成形体からなる吸音体を施工するに際し、該吸音体の肉厚みと背後空気層の厚みとの和ｄ（m）と騒音源の周波数ｆ（Ｈｚ）とが、下記（1）式及び（2）式を満たす条件で該吸音体を設置することを特徴とする吸音体の施工方法。

$$1.03\cdot(1/d)^{1.7}\leqq f\leqq 17.16\cdot(1/d)^{1.7} \quad (1)$$

$$100\leqq f\leqq 285\cdot(1/d)^{0.48} \quad (2)$$

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は樹脂発泡粒子を用いた吸音体およびその施工方法に関する。詳しくは、土木、建築、空調機器、及び、産業用機器の騒音防止に有効な樹脂発泡粒子の成形体を用いた吸音体およびその施工方法に関する。

【０００２】

【従来の技術】吸音材料としては、音のエネルギーが細孔状の材料内部で空気を振動させ、細孔内壁面との摩擦により熱損失することを利用する多孔質体、板や膜の振動へと変換することを利用する板状体や膜状体、共鳴現象を利用した穴あき板体等の種々の材料が利用されている。中でも多孔質成形体、即ち、具体的にはグラスウールやロックウール等の繊維集合体や連続気泡構造を有する軟質ポリウレタン発泡成形体、或いは、セラミック粉砕粒子を固めて焼成した多孔質成形体は吸音効果が得られ易い点でその利用は多い。

【０００３】しかしながら、これらのうちセラミック多孔質成形体は軽量性や価格上の点で不利なため高温や環境条件上の耐久性が求められる特殊な用途に限定されている。また、軟質ポリウレタン発泡成形体は、その製造条件により気泡膜の破壊状態が変化するため安定した吸音効果を得られ難い。そのため最も一般的には、安価性や軽量性に優れるグラスウールやロックウールが汎用されている。

【０００４】ところで、こうした多孔質成形体は高音、即ち高周波数領域の音に対しては優れた吸音効果を持つものであるが、低音、即ち低周波数の音に対しては吸音効果が薄く、吸音材料の厚みを大きく取ったり、或いは音波を反射する壁（以下、剛壁と呼ぶ）と吸音材料との間に背後空気層を大きく設けて対応せざるを得なかった。通常、剛壁から騒音の１／４波長の所に多孔質成形体を置くと最も大きい吸音率が得られる。例えば、２００Ｈｚ、１００Ｈｚの騒音に対しては、それぞれ４３０、８６０mmの空間厚みが必要となる。そのため多大※

$$1.03\cdot(1/d)^{1.7}\leqq f\leqq 17.16\cdot(1/d)^{1.7} \quad (1)$$

$$100\leqq f\leqq 285\cdot(1/d)^{0.48} \quad (2)$$

まず、本発明の第１について説明する。本発明で用いられる吸音体は１００～３０００Ｈｚ領域に吸音率が３０

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※な空間容積を必要とするものであり、低音の騒音防止対策としては実用性に薄れるものであった。

【０００５】一方、グラスウール等の繊維集合体では壁の内外に温度差がある場合には結露現象による吸水や、雨水の侵入による吸水によって吸音性能が劣化する。さらにこれら繊維集合体自体では柔軟なため、所望の形状に施工する場合にはパンチングメタルや治具等の副資材を用いて取付施工を行う必要があり、その上、作業時に皮膚を刺激したり、吸入による人体に有害な悪影響を及ぼす等の問題を有するものであった。

【０００６】

【発明が解決しようとする課題】本発明の目的は、騒音の発生源に対して、吸音性能、施工に必要な空間容積、及び施工の作業性の面から効率的な騒音防止対策を計ること、具体的には低周波数領域の吸音性能を高めることで背後空気層を含めた吸音施工に必要な空間寸法を縮小すること、施工時の作業を簡略化し作業性を高めること、環境条件の影響（特に吸水現象）による吸音性能の低下問題を排除すること等を可能にする吸音体の施工方法を提供することにある。

【０００７】

【課題を解決するための手段】本発明は樹脂発泡粒子の多数個が粒子間に空隙を残して互いに一体化した成形体を用いることにより、従来の吸音体が持つ上記欠点を改善するものである。すなわち、本発明の第１は１００～３０００Ｈｚの周波数領域に吸音率３０％以上のピーク周波数を有する樹脂発泡粒子の多孔質成形体からなる吸音体であり、その第２は１００～３０００Ｈｚの周波数領域に吸音率３０％以上のピーク周波数を有する樹脂発泡粒子の多孔質成形体をからなる吸音体を施工するに際し、該吸音体の肉厚みと背後空気層の厚みとの和ｄ（m）と騒音源の周波数ｆ（Ｈｚ）とが、下記（1）式及び（2）式を満たす条件で該吸音体を設置することを特徴とする吸音体の施工方法である。

【０００８】

％以上のピーク周波数を有する樹脂発泡粒子の多孔質成形体であることが肝要である。ピーク周波数が３０００

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IIzを越えるものは低音の吸音性が低下し本発明の目的に適さない。また、ピーク周波数が１００Ｈｚ未満のものは得ることが難しい。ここに吸音率とは、剛体壁に吸音体が密着した状態で、ＪＩＳ　Ａ１４０５に規定された垂直入射吸音率を言い、背後空気層を有する場合、つまり、音波を反射する剛体壁と吸音体との間に空気層を設定して測定された値ではない。本発明の吸音体では背後空気層を設けることにより吸音率のピーク周波数は低周波数側に移行し、ピーク吸音率は増加する傾向にある。また、本発明の吸音体は、これまで吸音体として樹脂発泡粒子の多孔質成形体を用いたものがなかったのに対し、吸音体として樹脂発泡粒子の多孔質成形体を用いたことを特徴とする。

【０００９】上記の樹脂発泡粒子の多孔質成形体を用いることによる効果について、図を用いて説明すると以下のとおりである。まず、図１は本発明で用いる多孔質成形体の断面構造例の一つを示す拡大様式図である。１は発泡粒子の部分、２は空隙部分を示す。本発明で用いる樹脂発泡粒子の多孔質成形体は上記要件①を満たすため、樹脂発泡粒子１の多数個が隣接する粒子表面の一部で面接合して一体成形されており、その粒子間に空隙部分２が形成されている。この空隙部分２は成形体厚み方向には一定形状を有してはおらず、次の断面ではその面積が広く、狭く、或いはその形状を違えた状態で連なり、または屈曲して連なり、この空隙部分２が成形体内部の多方向に道幅の割には急激な凹凸状、或いはジグザグ状に入り組んだいわゆるサウンドストリーム形構造の通路を形成することになる。このため入射した音波は上記音道を通過する際に多重反射や干渉による減衰効果をも発現することになる。

【００１０】本発明に用いる樹脂発泡粒子の多孔質成形体も多孔質体の基本的性質を有しており、音波が細孔状の吸音体内に侵入すると空隙内の空気が振動し、その際に空気と空隙の内壁面との間で摩擦を生じ、熱損失となって音のエネルギーが消費される。加えるに本発明では空隙を形成する内壁材料が多数の独立気泡構造からなる樹脂発泡粒子で構成され、内壁表面は非常に薄い膜を形成しているため音圧エネルギーを受けて膜の振動へと変換する機能を有し、即ち、低周波数の吸音性に優れた効果を持つことになる。しかも極めて多数個の樹脂発泡粒子からなる成形体であるため相乗的に低音域の吸音性が向上される。

【００１１】また、本発明の吸音体で用いられる樹脂発泡粒子の成形体においては、平均粒子径が１．５～５．５ｍｍの樹脂発泡粒子の多数個が隣接する粒子表面の一部で面接合し、全体容積に対して１５～４０％の容積空隙率を有して一体化していることが好ましい。以下これらの要件について説明する。発泡粒子における空隙の形状を規定する第一の因子は、その空隙を形成する粒子の大きさであり、樹脂発泡粒子の成形体の平均粒子径は

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１．５～５．５ｍｍの範囲であることが好ましい。これにより、サウンドストリーム形の通路、即ち音道の幅が決定される。粒子径が５．５ｍｍを越えると吸音体として受音する単位面積当たりの細孔空隙の個数が低下すると共に、全容積中の空隙の内壁総面積が低下し、音圧エネルギーを摩擦損失に変換する機能が低下し吸音性能が損なわれる。粒子径が１．５ｍｍ未満であると後述する製造方法との関係から吸音体の空隙率が低下し、吸音性能が低下すると共に、吸音体の芯部の粒子を熱接着することが難しく肉厚みの厚い成形体の製造が困難となる。こうした点から本発明の樹脂発泡粒子の平均粒子径は１．５～５．５ｍｍが好ましい。更に好ましくは２～４ｍｍである。

【００１２】なお、吸音体を構成する樹脂発泡粒子の粒子径分布も空隙率に影響し、吸音性能に影響してくる。粒子径の大きな粒子と小さな粒子が混在すると大きな粒子の間隙に小さな粒子が取り込まれるため上記サウンドストリーム形の通路を塞ぐことがあったり、容積空隙率が低下することがある。特に、大粒子と小粒子の径の比が小さな値の場合、加えるにその存在割合が特定の関係にある場合（大粒子／小粒子＝６／４）にはこの現象が著しく、吸音率の低下が起こる。

【００１３】本発明では使用に供する粒子群内で最大粒子径と最小粒子径との比の値が０．３～０．９に取ることが好ましい。すべての粒子径が同一であれば型内に充填された場合に細密充填となり、隣接する粒子同士が面接合して形成される空隙の割合が低くなり、吸音性能にとって好ましくない。また、本発明で用いられる吸音体において、音波の反射や干渉を効果的に発現させるには道幅が周期的に増減した導波路が三次元的に入り組み連通した構造となることが好ましく、粒子間の接合が点状ではなく面状の接合を成し、かつ、粒子間に形成される空隙を全容積に対して１５～４０％の容積空隙率とすることが好ましい。

【００１４】空隙の形状を規定する第二の因子は、樹脂発泡粒子が互いに隣接する粒子と面接合することである。これは隣接する粒子間の接着強度を高め成形体としての機械的強度を発現させるために重要なことであるが、吸音性能の面からも好ましいと考えられる。空隙に侵入した音波は種々な方向に進行し、反射散乱を繰り返して減衰していくが、空隙を形成する粒子間が点状に接合している場合には面接合している場合と比べ音波が反射される確率は低くなる。多重反射の頻度は粒子間が面状に接合することで増加する。これは、種々の方向から入射してくる音波を受け、壁表面を形成している樹脂発泡粒子の表皮膜が振動エネルギーに変換する確率も高まり、また、多重反射の頻度が増加することにより減衰効果も発現される。つまり、互いに連通する空隙ではあるが進行する音波にとって袋小路となる通路を多数形成させるためである。

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【0015】本発明では、このような粒子間の面接合の度合いが容易に調整できることも特徴である。即ち、吸音体を成形する際に膨張能を有する樹脂発泡粒子を用いることにあり、これらを金型に充填し、加熱して接合する際に発泡粒子が元の容積の1．08～1．41倍の容積となるよう加熱膨張させることにより型内の粒子が互いに押し合いながら面接合に至り、上記空隙形状を持つ吸音体が得られる。

【0016】また、吸音性能に大きな影響を与えるものとして空隙率がある。多孔質吸音体の空隙率も吸音性能に影響を及ぼすが、本発明においては樹脂発泡粒子の多数個が接合してなる吸音体であるため、15～40％の容積空隙率にすることが好ましい。空隙率が40％を越えると吸音成形体しての機械的強度が低下し、実質的に成形体としての使用が難しくなる。空隙率が15％未満であると吸音率が30％未満となり、吸音性能が劣化する。吸音性、及び機械強度の点から20～35％にとることがより好ましい。

【0017】次に、上述してきた本発明で用いる多孔質成形体の製造方法について説明する。本発明では樹脂発泡粒子の表面に該粒子の軟化発泡温度よりも低い温度で熱接着し得る接着用樹脂を添着することが隣接する粒子間の接着を容易にし、多孔質成形体の空隙率を高めること、及び特定の空隙構造を有する多孔質成形体を得るために有利である。樹脂発泡粒子は加熱により発泡、膨張する性質を有し、金型に充填して加熱された場合、個々の粒子自体が膨張し互いに隣接する粒子同士が押圧し合うため、表面の熱接着用樹脂を介して十分に強固な接着強度を得ることができるため本発明の目的には極めて好適である。更に、使用する樹脂の量を低減でき軽量性や断熱性も付加された多孔質成形体を得る点からも好ましい。

【0018】樹脂発泡粒子の表面に上記熱接着性樹脂を添着することは、樹脂発泡粒子が熱軟化し高度に膨張するに至る前、即ち、元の容積の1．08～1．41倍の容積となる温度で熱接着でき、その結果として発泡粒子の熱膨張が低減され高い空隙率を維持させることが可能となり、前述のような発泡粒子間の面状接合が容易となりサウンドストリーム形の空隙形状が形成され、吸音性に優れた多孔質成形体が得られる。また、上記製法を用いれば、エネルギー消費を低減でき、短時間での成形が可能となり、生産性にも優れた効果をもたらすものとなる。

【0019】本発明でいう樹脂発泡粒子とは汎用の熱可塑性樹脂、例えば、ポリスチレン、ハイインパクトポリスチレン、ＡＢＳ樹脂、ポリエチレン（高密度、低密度）、ポリプロピレン、ポリメチルチタアクリレート、ポリ塩化ビニリデン共重合樹脂、ナイロン－6、ナイロン－6，6、ポリエチレンテレフタレート等の樹脂に有機揮発性発泡剤や熱分解性発泡剤を含有さしめたものである。こうした膨張性を有する粒子として好ましくは、ポリスチレン、ポリエチレン、ポリプロピレン、ポリメチルメタアクリレート、塩化ビニリデン系樹脂、ポリフェニレンエーテルーポリスチレンアロイ等を素材樹脂とする発泡性樹脂粒子や発泡粒子があり、工業的に生産されている。

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【0020】もちろん、過度の加熱を行えば樹脂粒子の膨張が大きくなり粒子間の空隙が消失するため、これら発泡性粒子の膨張する温度と粒子表面に添着された接着用樹脂が熱接着する温度との関係を適切にした組み合わせを選択することが重要である。従って、発泡性樹脂粒子としては、スチーム等の熱媒加熱により緩慢な膨張速度を取るものは目的の空隙率を達成するために加熱条件を厳密に管理する必要もないため発泡性塩化ビニリデン系樹脂粒子は特に好適な素材粒子である。

【0021】発泡性塩化ビニリデン系樹脂粒子とは、塩化ビニリデン、及び、これと共重合可能なビニルモノマー1種以上とからなり、塩化ビニリデンが30重量％以上を含み、ガラス転移点が85℃以上の塩化ビニリデン共重合体に有機揮発性発泡剤を含有せしめた未発泡の樹脂粒子、及び、それを加熱発泡することにより得られる独立気泡構造の発泡粒子の両者を善い、共に加熱により膨張し、詳細には特開昭63－170433号公報、特開昭63－170434号公報に記載されるもので、発泡性粒子は含有する発泡剤の量を調整すること、あるいは予備発泡粒子の熟成条件、即ち、処理温度やその時間を調整することにより容易に得られる。

【0022】また、発泡断熱材として使用される空隙のない成形体を裁断した発泡破砕片を本発明の原料として供することもできる。次に、本発明の樹脂発泡粒子の表面に添着される熱溶着可能な接着用樹脂を説明する。該接着用樹脂としては、軟化温度が70℃以上で、かつ使用する合成樹脂素材粒子の軟化温度以下のものを選択することが好ましい。軟化温度が70℃未満のものでは粘着性を帯び易く表面に添着された合成樹脂素材粒子の流動性が悪く、製造過程での取扱いや金型への充填性が不良となる。また、成形された製品の使用環境によっては熱を受ける場合に変形したりして不都合を生じる。一方、接着用樹脂の軟化温度が合成樹脂素材粒子の軟化温度を越えると、成形加工時の加熱により素材粒子の熱変形が大きくなり、空隙率の高い多孔質成形体を得ることが難しくなる。

【0023】上記接着用樹脂としては、例えば熱可塑性接着剤として分類されるビニル系の酢酸ビニル系接着剤、アクリル系接着剤、エチレン－酢酸ビニル共重合接着剤やポリアミド系接着剤、ポリエステル系接着剤、熱か塑性ポリウレタン系接着剤、及び、極性基を有する熱可塑性樹脂として、ポリ塩化ビニル、アクリロニトリルースチレン共重合体（ＡＳ）、アクリロニトリルーブタジエンースチレン共重合体（ＡＢＳ）、スチレン－無水

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マレイン酸共重合体、スチレン－アクリル酸共重合体、アクリル系樹脂等がある。

【0024】本発明に好適な粒子素材である発泡性ポリ塩化ビニリデン系樹脂粒子の場合に好ましい熱接着用樹脂ものとしては、極性基を有するビニルモノマーが共重合された樹脂、即ち、ハロゲン基、カルボン酸基、エステル基、シアノ基、ニトロ基等を置換基として有するビニルモノマーが少なくとも5重量%以上共重合された樹脂であり、ASTM D 1525で測定されるビカット軟化点が70～115℃のものが使用できる。これら熱接着用樹脂は溶剤溶液、エマルジョン、或いはホットメルトの形で使用に供され、目的に応じて使い分けることができる。勿論、接着用樹脂の溶液中に種々な機能を付加させるための添加剤を加えることも可能であり、付加機能向上のためにも優れた製法である。例えば、有機、無機系の各種難燃剤、顔料や染料の着色剤、導電性物質、帯電防止剤、熱安定剤等のものが使用できる。

【0025】次に、本発明の樹脂発砲粒子の成形体の具体的な製造方法の一態様を説明する。発泡性樹脂粒子100重量部に対して接着用樹脂固形分が5～15重量部となるように接着用樹脂2～10重量%の溶剤溶液、或いは、20～60重量%のエマルジョン溶液を混合する。混合に際しては一般に粒体の混合として使用される混合機が使用でき、例えば、リボンブレンダー等を用いて接着用樹脂溶液を添加、またはスプレーして素材粒子の表面に被覆添着させる。

【0026】接着用樹脂固形分が5重量部未満では上記素材粒子が接着用樹脂を介して接合した成形体としての接着強度が不十分であり、15重量部を越えても強度的に有効には作用しなくて経済的に不利となる。接着用樹脂溶液の固形分濃度は目的に応じて適宜選択できるが、溶剤溶液の場合は2～10重量%、水性エマルジョンの場合には20～60重量%のものが好ましく使用できる。

【0027】上記混合を完了したら、必要に応じて乾燥し、加熱発泡して発泡倍率を調整する予備発泡工程に供＊

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＊したり、或いは、直接成形工程に供する。特に、形状の複雑な型物の成形に供する場合は発泡、乾燥処理して軽量性、流動性を持たした上で金型への充填性を向上させることは好ましい。こうした処理を行った樹脂発泡粒子は汎用の型内発泡自動成形機に供給され、金型充填後、接着用樹脂の軟化温度以上で、樹脂発泡粒子の発泡温度以下で加熱し、冷却の工程を経て成形体を得る。こうして高い空隙率を維持し、粒子間の空隙構造が制御された本発明の吸音性に優れる多孔質成形体が得られる。

【0028】次に、本発明の第2について説明する。吸音施工においては、吸音材料を設置するために必要な空間寸法をできるだけ縮小して、吸音性能を最大限に発現させることが最も重要である。このためには本発明の多孔質吸音体の吸音率が最大ピークとなる周波数と騒音源の周波数とを一致させることが好ましい。

【0029】本発明の多孔質成形体の吸音特性を用い、この具体的な内容を図2を用いて説明する。図2は、多孔質成形体の肉厚みと背後空気層厚みとの和dがその時の吸音率のピーク周波数Fに与える影響を解析したものである。直線①は多孔質成形体を従来の多孔質体が最も大きい吸音効果を発現するところである騒音源の1／4波長のところに設置した場合（d＝λ／4＝344／4f、すなわちf＝344／4d：ただし、音速は344m／分とする）を示し、直線②はその1／2の空間厚みとなる、多孔質成形体を従来の多孔質体が最も大きい吸音効果を発現するところである騒音源の（1／8）波長を示す。◎印は吸音率のピーク周波数において60%以上の吸音率を有し、且つ、dが（1／8）波長以下となる点であり、○印は上記吸音率が30%以上で60%未満で、かつ、dが（1／8）波長を越えて（1／4）波長以下となる点であり、×印は吸音率が30%未満であるか、またはdが（1／4）波長を越える点である。

【0030】まず、本発明においては多孔質成形体の肉厚みと背後空気層の厚みとの和d（m）と騒音源の周波数f（Hz）とが、下記（1）式及び（2）式を満たす条件で該成形体を設置することが必要である。

$$1.03\cdot(1/D)^{1.7} \leqq f \leqq 17.16\cdot(1/D)^{1.7} \quad (1)$$

$$100 \leqq f \leqq 285\cdot(1/D)^{0.48} \quad (2)$$

f＜1.03・（1／D）$^{1.7}$ では吸音率が逐次低下し、また多孔質成形体の肉厚みが小さくなりすぎ成形困難であるため適当でない。一方、f＞17.16・（1／d）$^{1.7}$ を越えても吸音率は徐々に低下し30%未満の吸音率となり、また、所望の吸音性能を出そうとすれば従来の多孔質体と較べてdが厚くなるため長所が発現できない。

【0031】f＜100では音波の波長が上記dに比べて大きくなるため、吸音率は急激に低下し、30%以上の吸音率を確保することは困難となり、一方、285・（1／D）$^{0.48}$＜fでは、背後空気層がない場合、即ち本発明の多孔質成形体の厚みだけで吸音施工する場合に相当し、吸音率のピーク周波数を超えた孔周波数側の音波に対しての吸音となるため、吸音性能は徐々に低下することとなる。

【0032】fとDの関係において、従来の吸音体では（1／d）の一次式で支配されることに対して本発明の多孔質吸音体では（1／d）のべき剰で支配されることに最も大きな特徴がある。換言すれば、本発明の多孔質成形体は背後空気層の厚みが薄くても特に低周波数の騒音に対して有効な吸音効果を示すことが大きな特徴であり、吸音のための必要空間容積を大きく低減させることができるものである。さらに、吸音率が60%以上で、かつ、施工空間厚みが従来の多孔質吸音体より半減

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できる（dが1／8波長以下となる）条件を付加させ、吸音性能と必要空間容積が低減されたより優れた施工とするには図2における◎印で囲まれる多角形ＥＦＣＧＨの領域を満足することが好ましい。ここに、直線ＥＦは吸音率が６０％以上となるに必要な多孔質成形体の下限の肉厚みでの背後空気層厚みと吸音率のピーク周波数との関係を表し、直線ＨＧはD＝（波長）／8を示す。多角形ＥＦＣＧＨを座標（D，F）で示せば、点Ｅ（0．０１４，２１９５）、点Ｆ（0．０８７，１００）、点Ｃ（0．３５，１００）、点Ｇ（0．３２，１３５）、点Ｈ（0．０２６，１６３０）となる。

【００３３】ここに本発明で言う吸音率とは垂直入射法による測定値で定義されるものであるが、実際の騒音では音源周波数も幅を持つものであり、種々の角度からの入射音があるため、施工仕様を一義的に決定できるものではなく実用評価に臨んで決定することが望ましいが、騒音の周波数領域内で音圧レベルが最大となる周波数をｆ（Ｈｚ）とし、このｆに関して少なくとも上記関係を満足することが必要である。

【００３４】本発明により従来技術では困難であった空隙率や空隙の大きさのコントロールが容易になり、使用目的に応じてこれらを制することで吸音性能を変化させたり、種々の形状に加工でき各種産業機器に装着可能な吸音成形体として好適なものが得られる。発泡性粒子を用いることにより、特に静音化が求められるエアコン、換気扇等の空調機器、ダクト等の風路を形成する部分で断熱性、軽量性の機能と吸音性を併せて持つ新規な工業部材として展開できる。また、建築分野においても特異な素材としての展開が期待できる。

【００３５】

【実施例】以下、実施例により本発明を説明する。なお、本発明で用いた評価方法は次の通りである。

（1）平均粒子径

１００ｇの樹脂発泡粒子をＪＩＳＺ８８０１で規定される、呼び寸法が5．６、４．７5．４、３．３５、２．３６、１．７、１．４、１mmである標準ふるいを用い分級をを行う。$d_i$ 目を通過して、かつ $d_{i+1}$ で止まる粒子の平均粒子径 $d_i$ 、重量割合 $X_i$ であれば、各分級品の平均粒子径は

$$d_i = (d_i \cdot d_{i+1})^{1/2}$$

で与えられる。

【００３６】全粒子の平均粒子径 $d_a$ は次式により求める。

$$d_a = \Sigma X_i d_i$$

（2）粒子径分布

前項の測定で分級して得た各群の内、最小粒子径 $d_{n1}$ を最大粒子径 $d_{n1}$ で除した値で定義する。

（3）引張強度

ＪＩＳＡ９５１１に基づき測定する。

（4）空隙率

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見かけのかさ容積（$V_i$ ）の多孔質成形体を一定量の水を張ったメスシリンダー中に浸漬し、その時の増加容積（$V_2$ ）を測定し、次式により求める。

【００３７】$\{(V_1 - V_2) / V_1\} \times 100$

（5）吸音率

ＪＩＳＡ１４０５に基づき垂直入射吸音率（定在波法）を測定する。

①　吸音体材料を特定する際の吸音率は背後空気層のない状態、つまり、剛壁に密着した状態で各周波数について測定する。

【００３８】②　背後空気層を設定した際の吸音率の上昇値、

背後空気層を設けた場合の吸音率値から①項の方法で測定された吸音率値をそれぞれの周波数において差し引いた値を言う。

③　吸水処理後の吸音率低下値、

①項で測定した吸音率から、吸音体試料にその全体積の５０％の容積の水を吸水させた後に①項と同様にして測定した値を差し引いた値を各周波数について求める。

【００３９】

【実施例１】塩化ビニリデン、Ｎ－フェニルマレイミド、アクリロニトリル、及びスチレンをそれぞれ４２，２．４，４４．３，１１．３モル％の組成比の混合物１００重量部に対して0．０２重量部のジビニルベンゼンを加えて懸濁重合法により共重合体樹脂粒子を得た。これにＨＣＦＣ－１４２ｂを７０℃にて２４時間かけて含浸処理を行った。得られた発泡性樹脂粒子は１０重量％のＨＣＦＣ１４２ｂを含有していた。

【００４０】この発泡性樹脂粒子１００重量部をリボンブレンダーに投入し、アクリル系エマルジョン（コニシ、ＳＰ－２１０）２０重量部を撹絆混合しながらスプレー添加し１５分間混合し、その後３５℃の温風を通気して乾燥して表面にアクリル系熱接着剤が添着された発泡性樹脂粒子を得た。この発泡性樹脂粒子を0．２ｋｇ／ｃｍ²-Gのスチームにより発泡した予備発泡粒子を得た。この予備発泡粒子を標準ふるいを用いて分級し、表１に示すような粒子径分布、及び、平均粒子径を有する５つのグループに配分した。

【００４１】それぞれのグループの予備発泡粒子を汎用の発泡スチロール用自動成形機にて３００×３００×２５mmの成形金型に投入し、一方加熱を0．１ｋｇ／ｃｍ²のスチームで１０秒間、続いて両面加熱を表１に示すスチーム圧で１０秒間行って、水冷し離型した。得られた空隙を有する成形体の空隙率、剛壁に密着した状態でのピーク吸音率とその周波数、及び、引張強度を測定した結果を合わせて表１に示す。

【００４２】表１の結果から明らかなように、本発明の樹脂発泡粒子による多孔質成形体は剛壁密着状態で１００～３０００Ｈｚの領域に高い吸音率を示し、空隙率の増加に伴い吸音率の値も上昇していることが分かる。

【0043】　　＊　＊【表1】

| 実施例1 実験No | 使用粒子の性状 | | | 成形条件 スチーム圧力 | 成形体の特性 | | | |
|---|---|---|---|---|---|---|---|---|
| | 粒子径範囲 mm | 平均粒子径 mm | 粒子径分布 mm | | 空隙率 % | ピーク吸音率 % | ピーク周波数 Hz | 引張強度 kg/cm2 |
| 1 | 2．8～4．0 | 3．5 | 0．70 | 0．2 | 35 | 93 | 2200 | 1．8 |
| 2 | 2．0～3．4 | 2．9 | 0．59 | 0．2 | 31 | 85 | 2000 | 2．0 |
| 3 | 4．8～5．6 | 5．2 | 0．86 | 0．3 | 26 | 45 | 1600 | 2．3 |
| 4 | 1．5～4．8 | 1．7 | 0．31 | 0．3 | 15 | 32 | 900 | 3．4 |
| 5 | 0．8～4．0 | 1．2 | 0．20 | 0．4 | 10 | 18 | 600 | 4．5 |

【0044】

【実施例2】上記実験Ｎｏ．１、２、３と同一の予備発泡粒子を用いて、同様の成形条件により、肉厚みがそれぞれ１００、５０、２５、１５、１０mmの多孔質成形体を得、空隙率を測定するとそれぞれ３０、３３、２５、２８、１５％であった。こうして得た多孔質成形体※について、背後空気層の厚みを変化させて吸音率の周波数依存性を測定し、吸音率が最大となるピーク周波数を求めた結果を表２に示す。

【0045】

【表2】

| 実験No | 使用粒子 | 成形体 肉厚 mm | 成形体 空隙率% | 吸音率のピーク周波数 上段：周波数（Hz） 下段：背後空気層（mm） | | |
|---|---|---|---|---|---|---|
| 6 | ③と同じ | 100 | 30 | 860 | 270 | 100 |
| | | | | 0 | 100 | 250 |
| 7 | ①と同じ | 50 | 33 | 1200 | 400 | 190 |
| | | | | 0 | 50 | 100 |
| 8 | ③と同じ | 25 | 25 | 1600 | 650 | 310 |
| | | | | 0 | 15 | 40 |
| 9 | ①と同じ | 15 | 28 | 2000 | 530 | 110 |
| | | | | 0 | 15 | 60 |
| 10 | ④と同じ | 10 | 15 | 2600 | 400 | 100 |
| | | | | 0 | 20 | 55 |

【0046】次に、上記の結果を吸音率のピーク周波数Ｆと多孔質成形体の肉厚みと背後空気層厚みとの和Ｄについて両対数プロットして図示すると図２となる。図中の直線①、②はそれぞれＤ＝λ／４、Ｄ＝λ／８を示す。ここにλは音波の各周波数における波長を表す。また、◎印は吸音率のピーク周波数における吸音率が６０％以上で、かつ、Ｄがλ／８以下であることを満足する点、○印は吸音率が３０％以上で６０％未満であり、かつ、Ｄがλ／８を越えてλ／４以下となる点、×印は吸音率が３０％未満であるか、または、Ｄがλ／４を越える点である。

【0047】さらに、ピーク周波数における吸音率が６０％以上で、かつ、従来の多孔質吸音体に較べ施工空間厚みが半減できる条件は多角形ＥＦＣＧＨの領域である。

【0048】

【実施例3】多孔質成形体として、実施例１の実験Ｎｏ．２の成形体を用いて吸音率の周波数依存性を下記の条件で評価した。

① 背後空気層を２５mmに設定した際の吸音率値から、剛壁密着状態の測定値を差し引いた値が３０％以上の上昇を示す場合を○、３０％未満の場合を×とした。

② 背後空気層の距離を変化させて吸音率を測定し、各周波数における吸音率が５０％を越える為に必要な空間厚み、即ち、多孔質成形体の肉厚み（２５mm）と背後空気層の厚みとの和Ｄが１００mm以内の場合を○、１００mmを越える場合を×とした。

③ 吸水処理後の吸音率が処理前に比べて１０％を越え

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て低下する場合を×、１０％以内を○とした。

【００４９】上記結果と施工性の評価とを合わせて表３に示した。なお、施工性の評価は空調用ファンの吸音を想定した場合の吸音体の取付作業の難易度、そのために必要な治具、剛資材の要否で判断した。本発明の多孔質＊成形体では金型を作成しておけば所望の形状の成形体が量産できること、また、そのまま装置に組み込むだけで良いため施工性に優れる。

【００５０】

【表３】

| 実施例３<br>周波数Hz | 背後空気層による吸音率の上昇% | 施工に必要な空間厚み mm | 吸水による吸音率低下 % | 施工性 取付の難易性 | 施工性 治具の要否 |
|---|---|---|---|---|---|
| 2000 | — | 0, ○ | 5, ○ | ○ | ○ |
| 1000 | — | 0, ○ | 5, ○ | | |
| 750 | 5, △ | 0, ○ | 3, ○ | | |
| 500 | 60, ○ | 10, ○ | 10, ○ | | |
| 250 | 53, ○ | 50, ○ | 3, ○ | | |
| 125 | 35, ○ | 75, ○ | 0, ○ | | |

【００５１】

【比較例１】密度が２４ｋｇ／ｍ³ であり、肉厚みが２５ｍｍのガラスウールの吸音体を用いて実施例３と同様な評価を行った結果を表４に示す。この場合には空気流によるガラス繊維の飛散を防ぐために綿布で包み縫製す※る必要があり、背後空気層を設けるためにはそれを支持するための部材や治具を必要とするため施工性に劣る。

【００５２】

【表４】

| 比較例１<br>周波数Hz | 背後空気層による吸音率の上昇% | 施工に必要な空間厚み mm | 吸水による吸音率低下 % | 施工性 取付の難易性 | 施工性 治具の要否 |
|---|---|---|---|---|---|
| 2000 | — | 0、 ○ | 60、× | × | × |
| 1000 | — | 0、 ○ | 50、× | | |
| 750 | 8、△ | 0、 ○ | 35、× | | |
| 500 | 15、△ | 0、 ○ | 40、× | | |
| 250 | 10、△ | 100、× | 10、○ | | |
| 125 | 3、△ | 200、× | 5、 ○ | | |

【００５３】

【発明の効果】本発明の樹脂発泡粒子を用いた吸音体及びその施工方法は吸音効果に優れ、特に低周波数の騒音防止に少ない空間容積で施工できる経済的にも優れた吸音体および施工方法である。

【図面の簡単な説明】

【図１】本発明の多孔質成形体の断面構造を示す模式図である。

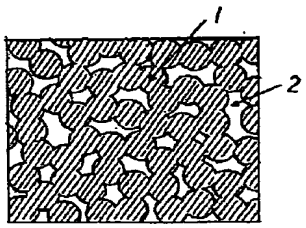
【図２】本発明の多孔質成形体の厚みと背後空気層との和ｄと吸音率のピーク周波数との相関を示す解析図である。

【符号の説明】

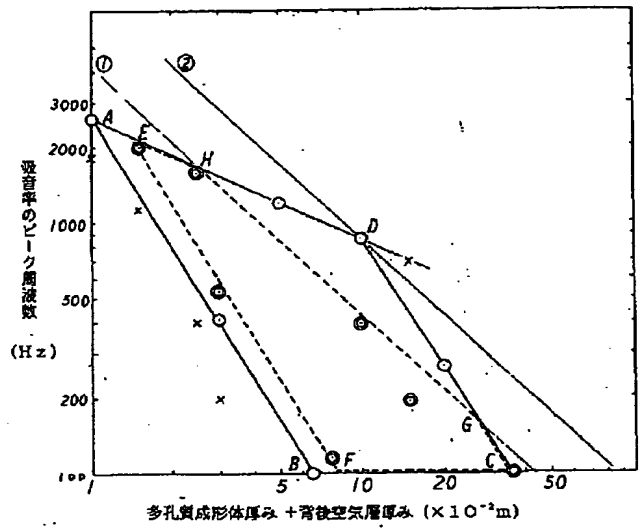
１　樹脂発泡粒子

２　空隙部分

【図1】




【図2】

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